

THE ETYMOLOGY OF BASIC CONCEPTS IN THE EXPERIMENTAL  
ANALYSIS OF BEHAVIOR

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The origins of many of the basic concepts used in the experimental analysis of behavior can be traced to Pavlov's (1927/1960) discussion of unconditional and conditional reflexes in the dog, but often with substantial changes in meaning (e.g., stimulus, response, and reinforcement). Other terms were added by Skinner (1938/1991) to describe his data on the rate of lever pressing in the rat (e.g., operant conditioning, conditioned reinforcement, negative reinforcement, and response induction and differentiation) and key pecking in the pigeon (shaping). The concept of drive, however, has largely disappeared from the current literature.

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To trace the concepts used in the experimental analysis of behavior back to their historical origins it is necessary to begin with the physiologists, who elicited a variety of glandular and muscular reactions by applying electrical or chemical agents at different points in the body. Because these instigating agents seemed to provoke the subsequent reaction without much regard to surrounding circumstances, early physiologists thought of them as akin to spurs or goads and gave them the name *stimuli*. In contemporary psychology, however, stimuli need not be stimulating: the word *stimulus* does not necessarily or even usually imply any instigation to action but merely a detectable element of the surrounding environment, capable of serving a variety of functions.

The physiologist's concept of the reflex was too narrow for the broader reaches of behavior, but it was nonetheless responsible for the adoption of the ubiquitous word *response* for its individual units. This word was quite appropriate for the second member of each reflex (i.e., the unique behavioral consequence of a given stimulus), but makes much less sense for behavior like bar pressing or key pecking, for which there need be no obvious

controlling stimulus. In particular, the phrase "rate of responding" reads almost like a contradiction in terms. E. L. Thorndike, who was much better known to early psychologists, had used the word *act* (e.g., Thorndike, 1911), but behavior-analytic vocabulary stems from Pavlov. We count "responses" even when there is no mention of any eliciting stimulus.

CONDITIONAL AND UNCONDITIONAL

The research for which Pavlov received his Nobel Prize in 1904 (Babkin, 1949; Pavlov, 1957; Pawlow, 1902) was pure physiology. Using surgical interventions, he traced the neural pathways by which the introduction of such initiating agents as meat, powdered biscuit, or a mild solution of hydrochloric acid produced salivary and gastric secretions in the dog. These were true reflexes, characterized—at least within relatively broad limits—by a consistent and universal reaction to the appropriate stimulus. These, then, were the reflexes that Pavlov described in his Nobel Laureate Address as *unconditional*, although there were, in fact, certain conditions attached. By contrast, to the varied reactions developed in different dogs during their exposure to previously ineffective stimuli he applied the label *conditional* (see Pavlov, 1941; Skinner, 1938/1991, pp. 61, 431), emphasizing the fact that these reflexes, as he still called them, were not uniform among all dogs but were dependent upon contingencies to which they were exposed within the laboratory. (According to Pavlov's colleague and translator, W. H. Gantt, the traditional En-

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glish term *conditioned* is an erroneous rendering of the original Russian word, условный; ooslovny [Pavlov, 1928, p. 79; see also Gantt, 1973; Skinner, 1966, p. 74].)

The research for which Pavlov (1927/1960) became known both to psychologists and to members of the general public was a systematic examination of the factors that increased or decreased the flow of saliva elicited by an arbitrary stimulus (i.e., conditional stimulus) that had been paired in time with one that was already effective (unconditional stimulus). (If Pavlov had had a better understanding of the dynamics of the situation, he might well have called the conditional stimulus a discriminative stimulus [Dinsmoor, 1995].) Although modern research in Pavlovian conditioning has uncovered much rich and complex material (e.g., Rescorla, 1988), textbook representations tend to hark back to the original, physiologically oriented work of Pavlov himself and to Watson's 1920s version of behaviorism. In particular, the continued use of the word *reflex* conjures up images that are far less interesting to the general public and to most psychologists than the overall behavior of an intact organism. It has had a prejudicial effect on the reception accorded to Pavlovian research and to early behavior-analytic writings (e.g., Keller & Schoenfeld, 1950/1995; Skinner, 1938/1991) using the same vocabulary. This is where cognitive terminology secured its initial victory in the war of words with behaviorism.

#### REINFORCEMENT

Key terms like *reinforced* and *reinforcement*, which now serve as the approved labels for the central concept in our discipline, arose largely by accident. They are universally, and in a sense, correctly attributed to Pavlov (1927/1960), but in the historic compendium of his addresses published in 1928, the word *reinforcement* appears only once, and then as a rather loose translation of the original Russian text (Razran, 1955). According to Razran, Pavlov and his students never used the term *reinforcement* for the trials preceding the full-fledged emergence of the CR. In the more systematic series of lectures published in 1927, Pavlov often used the notations *reflex reinforced* or *stimulus reinforced* in the trial-by-trial protocols for individual experiments, but reinforcement never appeared as a theoretic-

cal category of any sort nor was it ever used in connection with the initial conditioning of the salivary response. Apparently these phrases referred to the practice, routine in Pavlov's laboratory, of reinvigorating the conditional salivary secretion, after it had been weakened by repeated elicitations, by presenting one or more trials in which the conditional stimulus was once again followed by the original unconditional stimulus. If the unconditional stimulus was not presented on a given trial, the effectiveness of the conditional stimulus declined, and the trial was classified as one of *extinction*, another term apparently borrowed directly from the common, everyday language.

#### OPERANT AND RESPONDENT

Working in the Department of Physiology at Harvard, shortly after Pavlov's findings became available in English translation, Skinner (1930 ff.) was engaged in a systematic study of the frequency with which a rat depressed a crossbar or lever that produced pellets of food. He noted increases and decreases in the frequency of pressing with the delivery or nondelivery of successive pellets and extended the application of the terms *reinforcement* and *extinction* to this new phenomenon, which he treated as a second form of conditioning. There were obvious differences in procedure, of course, which called for a corresponding distinction in categorization. The distinction he settled on was that with the bar pressing preparation the strengthening agent was delivered whenever a response occurred, rather than whenever an antecedent stimulus was presented. Accordingly, to differentiate the two procedures, he formally labeled his procedure of pairing the reinforcer with the response *Type R conditioning* and Pavlov's procedure of pairing the reinforcer with a stimulus *Type S conditioning*.

The procedural distinction between Type S and Type R conditioning was faithfully reproduced in Keller and Schoenfeld's introductory textbook, *Principles of psychology: A systematic text in the science of behavior*, published in 1950 (1950/1995), but it soon faded from use in the primary literature in favor of a pair of terms that were roughly equivalent in meaning but may have sounded less pretentious to research personnel. For the class of behavior that was customarily conditioned by Pavlov's

Type S procedure—pairing the strengthening stimulus with a conditional stimulus—Skinner used the term *respondent*, the rationale being that in both the unconditional and the conditional cases the subject's behavior arose in response to a stimulus deliberately and explicitly presented by the experimenter. The term *operant* was coined to refer to the class of behavior that was customarily conditioned by Skinner's Type R procedure, pairing the reinforcing agent with a response. The mnemonic rationale for this usage was that this type of behavior operated on the environment to produce its reinforcers.

The behavior of living organisms is complex, and Skinner's distinction between the two types of conditioning has sometimes been questioned (see Coleman, 1981; Gantt, 1967; Hearst, 1975). There certainly are many similarities in the functional relations obtained for the two categories, but when the reinforcer is correlated only with the presence or absence of an antecedent stimulus, as in respondent conditioning, there is no provision for changing the form of the response, as in successive approximation or response differentiation in general, both extremely important processes. In my undergraduate teaching, I have compared the problem of categorizing conditioning procedures to that of categorizing human beings. We are all one species, to be sure, with many features in common. The common ground cannot be dismissed, but our species also is characterized by a sexual dimorphism: There are two genders, and there are occasions on which the distinction becomes quite important. If it were not for that difference, for example, our species would be in serious trouble from a genetic point of view.

#### CATEGORIES OF REINFORCEMENT

In *The Behavior of Organisms* (1938/1991) Skinner added modifiers like *negative* or *conditioned* to the term *reinforcement*, as used within the operant context. Initially, he used the two-word phrase *negative reinforcement* for a consequence that had a negative or subtractive effect on the rate of responding, analogous to the additive effect of ordinary, or positive, reinforcement but opposite in direction. That is, he used it to designate what is now called punishment. Later, he abandoned this usage as "incorrect" (Skinner, 1979).

In his revised terminology the word *reinforcement* consistently referred to an increase or strengthening of the behavior that was followed by an appropriate consequence, but the words *positive* or *negative* are now used to describe the direction of the reinforcing operation, that is, whether it was the addition (presentation) or subtraction (withdrawal) of a stimulus that led to the increase in responding. In their treatment, Keller and Schoenfeld (1950/1995) dealt with the problem by giving both definitions (p. 61), although they favored the second, revised usage. In *Science and Human Behavior* (1953) Skinner consistently followed the revised usage, referring, for example, to the conditioned negative reinforcing effects of stimuli that preceded primary aversive situations, the stimulus function that leads in the Hullian tradition to the hypothetical construct of fear.

#### ACQUIRED REINFORCERS

For the presentation of stimuli that were not inherently reinforcing but that had acquired that function through a pairing procedure like that used in Pavlovian conditioning, Skinner (1938/1991) used the term *conditioned reinforcer*. Keller and Schoenfeld (1950/1995) stressed the importance of this topic in its application to complex patterns of behavior and in its extrapolation to everyday human affairs. They devoted an entire chapter to it. In this case, however, they gave Skinner's terminology only a passing mention, adopting instead the terminology that was at the time standard in the research literature, *secondary reinforcement* (Hilgard & Marquis, 1940; Hull, 1943). Eventually, however, most behavior analysts returned to the vocabulary used by Skinner.

#### GENERALIZATION AND INDUCTION

Skinner again departed from conventional usage (Hilgard & Marquis, 1940; Keller & Schoenfeld, 1950/1995) when he adopted the term *induction*. Pavlov (1927/1960) had noted that increases or decreases in the magnitude of the salivary response to the conditional stimulus were accompanied by similar but smaller increases or decreases in the same response to other stimuli, in accord with their degree of similarity to the conditional stimulus. He called this phenomenon

generalization. However, because Pavlov's type of conditioning was restricted to the elicitation of a previously specified response by a new stimulus, he had had no need to consider a corresponding spread of the effect of reinforcement among similar responses to the same stimulus. With operants, however, Skinner (1938/1991) also observed an analogous spreading of the effects of reinforcement in accord with the degree of similarity between different forms of responding. He began referring to the broadening of the reflex along either dimension by the same term, *induction*, qualifying it where necessary by noting whether it was induction between stimuli or induction between responses. For a transfer of the same response between different stimuli, Keller and Schoenfeld (1950/1995) stuck with the phrase *stimulus generalization*, which was already standard in the conditioning literature (see Hilgard & Marquis, 1940), but for a transfer among different forms of behavior to the same stimulus they followed Skinner's lead, adding *response induction* to their vocabulary.

#### DIFFERENTIATION

Skinner's expansion of the topic of conditioning to cover operant as well as respondent behavior led to a novel concept of critical importance, particularly in training organisms that were less verbally proficient, like nonhuman animals or developmentally disabled humans. When the reinforcer was delivered following the occurrence of the response rather than following the presentation of a prior stimulus, variations in the topographical form (e.g., paw vs. nose, beak vs. wing, running vs. swimming, left vs. right, up vs. down) or quantitative dimensions (e.g., intensity, duration, amplitude) of individual instances of the target behavior could be selectively reinforced. The resulting shift in the content of the subject's response class was described in chapter VIII of *The Behavior of Organisms* (1938/1991) under the title of *response differentiation*. Extending this line of thought eventually led to such related concepts as successive approximation (Skinner, 1938/1991) and shaping (Skinner, 1953) for the conditioning of new forms of response not originally observed in the experimental situation. Peterson (2000, 2001) has brought out the distinction between these latter con-

cepts. The earlier term, *successive approximation*, referred to changes in the form of the response produced by changing discrete requirements set by the physical apparatus (e.g., force, duration) for the response to be reinforced; *shaping* was continuous, rather than discrete, and was conducted by visual observation and selective reinforcement controlled by a switch operated by hand. The difference may seem trivial, but Skinner's comment was "I remember that day as one of great illumination" (Skinner, 1979, p. 268; see Peterson, 2004).

#### DISCRIMINATION

It is interesting to compare early and late treatments of stimulus discrimination: In *The Behavior of Organisms* Skinner (1938/1991) summed up his empirical data in terms of the behavioral processes they revealed. For example, in his Law of the Discrimination of the Stimulus in Type R, he declared that "The strength acquired by an operant through reinforcement is not independent of the stimuli affecting the organism at the moment, and two operants having the same form of response may be given widely different strengths through differential reinforcement with respect to such stimuli" (p. 228). In a section beginning eight pages later (p. 236), he did compare the discriminative function of a stimulus with an eliciting function and eventually the reinforcing and emotional functions, but he offered no formal definition. In their treatment, Keller and Schoenfeld (1950/1995) gave greater prominence to the categorization of stimulus functions than to a description of the behavioral processes: "We may refer to the bright light in the presence of which reinforcement occurs, as  $S^D$  (ess-dee) and the dim light, in the presence of which there is no reinforcement, as  $S^\Delta$  (ess-delta). . . . Each is a discriminative stimulus" (p. 118). They went on to present a number of examples throughout the remainder of the book. Together, the two entries, *discriminative stimuli* and *discriminative stimulus*, accounted for almost a full column in their index. Keller and Schoenfeld's presentation may have been more accessible to the new reader than Skinner's, but it also may have led to a conceptual bifurcation of the actual continua of stimuli (cf. Donahoe, Palmer, & Burgos, 1997).



## FADING

The procedure known as fading represents a reversal of the usual historical trend: It came to basic research from an applied area, rather than the other way around. As used in programmed instruction, it referred to a gradual degradation of an originally adequate stimulus that left the response under the control of one that previously had been ineffective. In Skinner's original writings (e.g., Skinner, 1954), it was known as *vanishing*, and I suspect the change in vocabulary was designed to provide a transitive, rather than an intransitive verb, for the concept. It was awkward to refer to *vanishing* a stimulus, but entirely grammatical to refer to *fading* it. In *JEAB's* cumulative index, there is no entry under the term *fading* prior to 1963 (Terrace, 1963).

## DRIVE

The hypothetical construct of *drive* was quite popular at the time Skinner began his work (e.g., Young, 1936) and quite prominent in his early writings, but it was relegated to the 9th and 10th chapters (pp. 341 ff.) of *The Behavior of Organisms* (1938/1991), following a much more extensive discussion of the ways in which a reinforcing stimulus may be related to behavior. It was a "hypothetical middle term" or "state" (p. 24) that was influenced by several different operations and that in turn affected several different classes of behavior. In the case of hunger, for example, the amount of food ingested and the length of time since eating were the controlling variables. Other things being equal, the rate of eating or of behavior that had been reinforced with food served as measures of the hunger. Keller and Schoenfeld (1950/1995) reviewed what Skinner had written and added a proviso that may also be significant: that neither respondent nor operant conditioning was possible with a zero level of drive (p. 264). (The animal would not consume the food or water that served as a reinforcer.) These authors also extended the category of drive to include a second case, the presence, absence, or intensity of an aversive stimulus (p. 274). In their treatment of light, tone, and shock aversion, however, the primary criterion for identifying a drive was not the effect of the presence of the drive on the cur-

rent rate of responding, but the reinforcing effect of removing or reducing the intensity of the stimulus. (For discussions of drive vs. discrimination interpretations of aversive stimuli, see Dinsmoor, Hughes, & Matsuoka, 1958; Dinsmoor & Winograd, 1958; Michael, 1982.)

The newcomer to a given field of inquiry may assume that its terminology has been handed down from ancient times on tablets of stone, or perhaps established by some prestigious Committee on Nomenclature. But, in the experimental analysis of behavior, at least, it has emerged haphazardly and, dare we say, cumulatively from the needs of the laboratory and the classroom.

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